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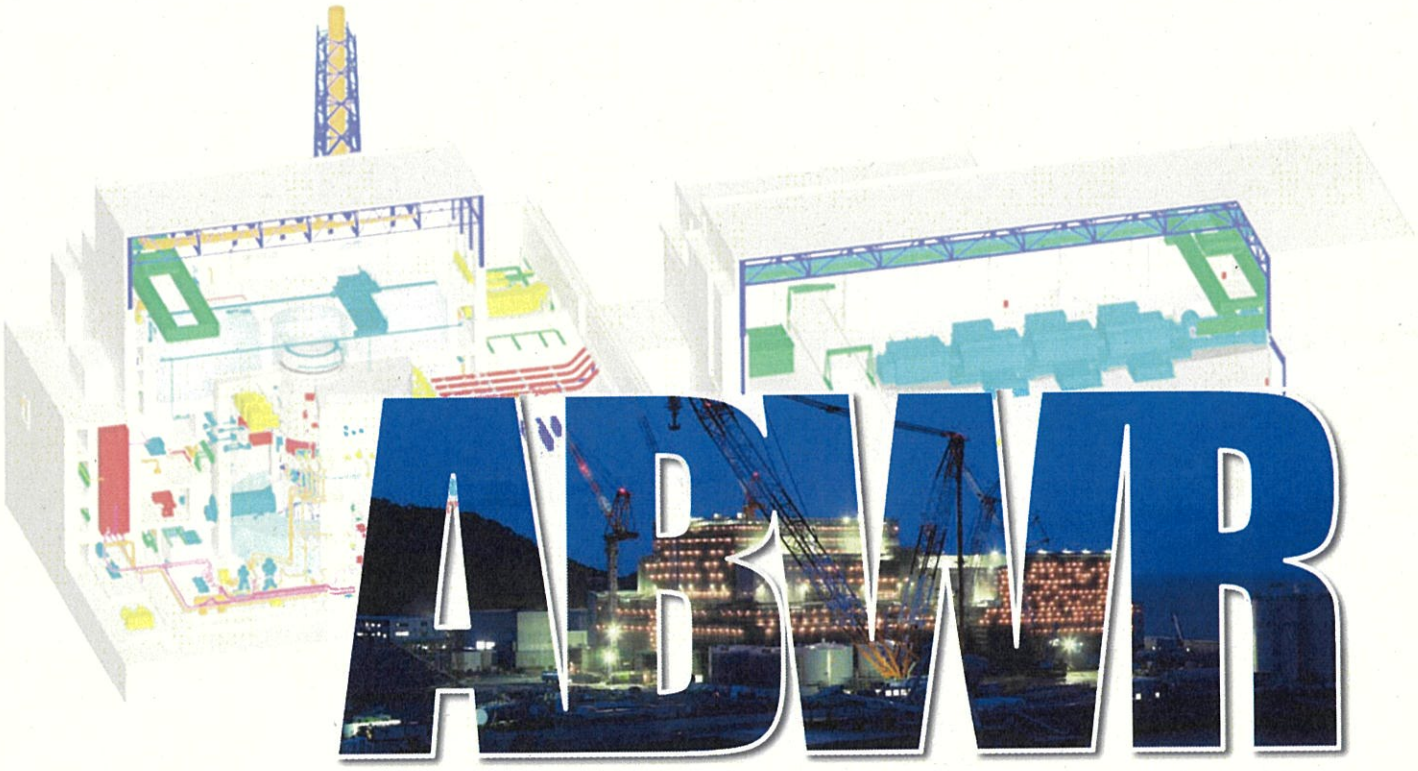
UK ABWR Generic Design Assessment

Generic PCSR Chapter 22 : Emergency Preparedness



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Executive Summary

This chapter gives an overview of the emergency preparedness arrangements for an operating UK ABWR. It explains the approach to providing an integrated response to abnormal events or emergencies, as currently envisaged for the UK ABWR design built on a generic site. It describes conceptual arrangements that are not developed further in GDA, but are considered to be an important piece of information in providing the UK Regulators with early visibility of the anticipated future developments for an actual licensed site.

Responsibility for safety of a future licensed site that is based on the UK ABWR design will rest with the nuclear site licence holder. The future licensee will need appropriate arrangements to ensure that it can safely manage accident and emergency situations, but specific arrangements go far beyond what needs to be considered for a generic site within GDA scope. However, certain elements of the nuclear regulatory regime are relevant to GDA and are considered and applied as appropriate in this chapter.

This chapter demonstrates in principle how arrangements can be put in place on a specific UK ABWR site to support an adequate and proportionate response to any abnormal event or emergency, and to reduce the risks to levels that are As Low As Reasonably Practicable (ALARP). It does not include details of the site specific requirements due to geographic location, local requirements or regional differences.

The information provided includes an overview of relevant international guidance and the applicable regulations. The strategy for emergency preparedness is described, including interactions between the licensee and local and national organisations and considerations of the anticipated resources required by the licensee to deal with any accident or emergency is provided. The Structures, Systems and Components (SSCs) that are included within the UK ABWR design reference to facilitate effective response to accidents and emergencies are also briefly described, with links provided to other Generic PCSR chapters that provide further details of these particular SSCs.

The Severe Accident Management strategy, consistent with insights from fault analysis, has also been provided. This includes early development of event based and symptom based procedures for abnormal events, emergencies and severe accidents. In the corresponding site specific development, currently underway, benchmarking against the generic procedures is necessary to ensure all significant GDA analysis insights are captured. The Accident Management framework will be based on the suite of generic procedures and they will be adapted as necessary for site specific use.

Clearly, significant future development work will be required in the site specific safety case to further develop the detailed requirements of Emergency Preparedness as the design progresses. This work will be the responsibility of any future licensee and operator.

22.1 Introduction

This Chapter presents a high level summary of the emergency arrangement proposals, accident Management concept and a framework of legislation for the UK ABWR.

22.1.1 Background

The background to the chapter covers the emergency preparedness requirements, SSCs, strategy and resources required to support an adequate and proportionate response to any accident or emergency at an operating ABWR.

22.1.2 Document Structure

The following sections are included in this chapter:

Section 22.2 Purpose and Scope:
This section explains the objectives of the chapter, and lists the main systems that are within the scope of this chapter.

Section 22.3 Legislation, Guidance and Requirements:
This section provides an outline of requirements from international and UK legislation and guidance.

Section 22.4 UK ABWR Design, Safety and Emergency System:
This section provides an initial definition of Emergency SSCs required for the ABWR.

Sections 22.5 Insights from OPEX and post Fukushima learning:
This section provides the Insights from OPEX (IAEA, BWROG) and post Fukushima learning.

Section 22.6 Emergency Organisation, Facilities and Response:
This section provides a definition of emergency facilities as part of an integrated site emergency response.

Section 22.7 Accident Management:
This section provides a definition of the proposed response structure to support response at an operating ABWR. The design aspects that is specific to on-site accident management in bringing the reactor to a safe shutdown and in the mitigation of severe accidents.

Sections 22.8 Consideration of Lifecycle Aspects:
This section provides Emergency preparedness during Construction and Early Commissioning and Emergency preparedness from the receipt of nuclear fuel.

Section 22.9 Conclusions:
This section provides a summary of the main aspects of this chapter.

Section 22.10 References:
This section lists all documents referenced within this chapter.

Appendix A – Document Map:
The document map showing documents that support this chapter is provided in Appendix A.

22.2 Purpose and Scope

22.2.1 Purpose

The purpose of this chapter is to describe the emergency preparedness requirements, SSCs, strategy, resources and the approach for the integrated response to any accident or emergency which includes radiological, security, chemical or conventional emergencies. The approach is based on international and UK legislation, guidance and other emergency planning doctrine.

22.2.2 Scope

This chapter covers emergency SSCs and the approach for an integrated response currently envisaged for the ABWR design built on a generic site, and as a result does not include details of site specific requirements due to geographic location, local requirements or regional differences. However, this chapter includes conceptual arrangements that will not be described further in the GDA but are considered as an important piece of information in providing the Regulators with an early visibility of future developments. Future development work will be required in the site specific PCSR to further define the detailed requirements of Emergency Preparedness as the design progresses. Although the emergency preparedness response will be integrated with other requirements such as environment, chemical and security this chapter will not go into any details for other response areas but will outline the integrated response structure.

22.3 Legislation, Guidance and Requirements

22.3.1 International Requirements and Practices

The IAEA Safety Standard Series recognises that "*good preparedness in advance of an emergency can substantially improve an organisations emergency response. One of the most important elements of emergency preparedness is the coordination of arrangements among the different bodies involved to ensure clear lines of responsibility and authority*".

To support this the IAEA have published GSR Part 7 - Safety Requirements for Emergency Preparedness and Response for a Nuclear or Radiological Emergency [Ref-1] as a safety standard. This safety standard also supports the IAEA Fundamental Safety Principles [Ref-2] and in particular Principle 9 which requires arrangements to be made for preparedness and response for a nuclear or radiation incidents.

These are also supported by a number of other IAEA documents on the subject of Emergency Preparedness and Accident Management and are available as guidance to assist member states in the application of safety requirements. Specifically these include GS-G-2.1 Arrangements for Preparedness for a Nuclear or Radiological Emergency [Ref-3] and NS-G-2.15 Severe Accident Management Programmes for Nuclear Power Plants [Ref-4].

IAEA SF-1 - Fundamental Safety Principles

The IAEA Fundamental Safety Principles have been established to provide the objectives, safety principles and concepts that form the base of the IAEA safety standards. The fundamental safety principles also provide the basis for the requirements and measures for the protection of people and the environment against radiation risks and for the safety of facilities and activities that give rise to radiation risks.

Principle 9 specifically relates to Emergency Preparedness and requires arrangements to be made for preparedness and response for a nuclear or radiological emergency. The primary goals under principle 9 are:

- To ensure that arrangements are in place for an effective response at the scene and, as appropriate, at the local, regional, national and international levels, to a nuclear or radiation emergency;
- To ensure that, for reasonably foreseeable incidents, radiation risks would be minor;
- For any incidents that do occur, to take practical measures to mitigate any consequences for human life and health and the environment.

The UK ABWR will fulfil these goals by ensuring that adequate, approved and appropriate emergency arrangements and procedures are in place at all times during its lifecycle. The arrangements developed for response at the scene will be clearer linked with the wider civil emergency response to ensure an integrated response to any accident or emergency.

The UK ABWR will put appropriate measures in place to prevent and minimise any impact from radiation risks and hazards following the defense in depth model. The Emergency response procedures will form the 5th level of defense and will only be required following failure of all other

levels of defense. When this level is reached and emergency response is activated procedures and processes will be in place to manage and control any radiation exposure that may pose a risk to human life and health. This will include controls on intervention personnel and response teams at the scene and controls to reduce and minimise the radiation exposure and risk to the public.

Control measures will also include procedures to protect the environment from the risks and hazards following a radiation emergency including initial monitoring and collection of data to inform the correct mitigation measures and initial control measures to halt or reduce any damage to the environment while a strategy for mitigation is formed.

IAEA GSR Part 7 - Preparedness and Response for a Nuclear or Radiological Emergency

GSR Part 7 [Ref-1] is a revised edition of the IAEA Safety Standard Series No.GS-R-2, updated to include experience and learning from the accident at the Fukushima Daiichi NPP. It has been produced as a safety standard to support the IAEA Fundamental Safety Principles [Ref-2], and also supports the IAEA Nuclear Security Fundamentals [Ref-5] particularly Essential Element No. 11, which requires planning for preparedness and response for nuclear security events.

GSR Part 7 [Ref-1] establishes the requirements for an adequate level of preparedness and response for a nuclear or radiological emergency which, in application of these requirements is intended to mitigate the consequences of a nuclear or radiological emergency if all attempts to prevent it fail. It lays out the principle goals of emergency preparedness and response, establishes the general requirements to be met and establishes a graded approach for emergency preparedness using a threat grouping according to the related threats.

The UK ABWR will have in place adequate and approved emergency arrangements, within an On-site Emergency Plan approved by the regulator. These arrangements will cover requirements under the Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR) [Ref-6] and therefore also be fully integrated with the requirements on the local Authority to prepare an Off-site Emergency Plan. The Off-site Emergency Plan will then also integrate with the requirements under the Civil Contingencies Act [Ref-7], the National Nuclear Emergency Planning and Response Guidance (NNEPRG) [Ref-8] and civil emergency response arrangements from the local level to national and governmental response.

These arrangements will also be integrated into the international response through conventions such as the Convention on Early Notification of a Nuclear Accident (CENNA) [Ref-9] and the Convention on Assistance in the Case of a Nuclear Accident Or Radiological Emergency (CANARE) [Ref-10].

Clear and assigned roles and responsibilities in a nuclear or radiological emergency are defined across the UK through various national, regional and local response plans under the Civil Contingencies Act [Ref-7], the NNEPRG [Ref-8], REPPIR [Ref-6] and the Nuclear Installations Act (NIA) [Ref-11]. The UK ABWR will support this UK response by having clear and assigned roles and responsibilities within the On-site Emergency Plan and Handbook which will identify the emergency organisation and its roles.

This organisation will include a number of initial response roles which will be allocated to shift

operations staff who will be available on-site at all times. Their role in the response is to ensure the prompt activation and initiation of response measures are enacted within the required time frame and to prepare the emergency response structure and facilities ready for the developing situation and for on-coming support as necessary. The emergency response organisation will be designed with enough depth to be able to deal with a number of coincidental incidents occurring at the same time. This includes not only the response teams at the scene but also the command and control structure to be able to control with sufficient resources such situations.

The UK ABWR will require the production of strategies for the protection of the public, personnel, plant and the environment. Radiological protection strategies for the protection of the public will be produced to support decision making in an emergency. These radiological protection strategies will be based upon the UK Emergency Reference Levels produced by Public Health England (PHE) [Ref-12] which provides information on the range of countermeasures that can be carried out against the averted dose levels they provide.

Operational actions will also be determined for the UK ABWR through Emergency Operational Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs) which will be produced following the safety case and PSA assessments. These assessments will also support the production of environmental protection strategies which will involve minimizing the impact of an event on the environment and then providing guidance on mitigation and clean-up strategies dependent on levels and types of hazards.

Other protection strategies will be developed to support local and regional response through extendibility or outline planning principles and levels to again aid decision making to protect the public.

The UK ABWR design will incorporate various instrumentation across the plant that will monitor the conditions in an event this will include radiation monitoring and severe accident instrumentation. This information will be constantly monitored and reviewed by the Main Control Room Team, Technical Support Centre Team and the Emergency Control Team and will help inform decisions on protective and mitigatory actions required.

This technical information will also be communicated to the local and regional response within the Strategic Coordination Centre (SCC) via an Incident Information Management System. This information will be used to inform decision making by the Strategic Team on public countermeasures and protective actions to be taken. This information will also be passed from the SCC to the technical supporting teams for the government at the Cabinet Office Briefing Room where this information will be used to give updates and advice to the Prime Minister and their supporting team.

Initial communication of a radiation emergency to the public within the REPPIR Emergency Planning Area will be provided directly from the site via an automated notification and messaging system. Following establishment of the local, regional and national emergency arrangements and activation of the Off-site Emergency Plan, ongoing communication to the public will be through the Police and Government Media Teams and the national and local media infrastructure.

IAEA GS-G-2.1 - Arrangements for Preparedness for a Nuclear or Radiological

Emergency

GS-G-2.1 [Ref-3] is a guide intended to assist Member States in the application of the Safety Standard Requirements on Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series GSR Part 7 [Ref-1].

The primary objectives of the Safety Guide are to provide guidance on the Safety Standard requirements, describe appropriate responses to a range of emergencies and provide background information on past experience that provided the basis for the requirements. It uses the same graded approach as GSR Part 7 with an operational UK ABWR being grouped as a category 1 facility.

22.3.2 UK Requirements

The detailed Emergency Arrangements for a UK ABWR design at a chosen location will be developed, in the site specific PCSR phase in compliance with the statutory requirements including; the Control of Major Accident Hazards Regulations 1999 (CoMAH) [Ref-13], Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) [Ref-6] and Nuclear Site Licence Condition 11 – Emergency Arrangements [Ref-14] (and the underpinning guidance). The following gives an overview of the UK requirements for Emergency Arrangements and covers how some of the high level requirements will be met.

National Nuclear Emergency Planning and Response Guidance (BEIS)

The National Nuclear Emergency Planning and Response Guidance (NNEPRG) [Ref-8] provides the context within which UK emergency planners and responders need to approach radiation emergencies. It supports civil contingencies planning to help deliver a single framework for response in the UK.

The document is structured into three parts:

Part 1: Preparedness – Describes how to prepare for responding to nuclear emergencies. It covers the basics of understanding the nuclear risk, off-site emergency planning requirements from the Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR) [Ref-6] and testing of off-site and recovery plans. The guidance is mainly focused on giving off-site agencies and local authorities the background and guidance to support off-site planning.

Part 2: Response – Describes what nuclear emergency responders should consider to deliver an effective and consistent response to a radiation emergency at an NPP. It also brings together good practice and guidance from on-site and off-site emergency arrangements and learning from Civil Contingencies Act [Ref-7] and the emergency services joint working doctrine. The response structure for the UK ABWR will align with the response concepts described within the NNEPRG, and it will directly integrate with two of the four interconnecting tiers of response at the Site and local Strategic levels with information from these levels feeding directly into the National and International levels.

At the Site level the UK ABWR Emergency Control Centre (ECC) will manage the operator's on-site response and coordinate and interpret the incident information. This incident information will be passed to a Company Support Centre (CSC) where a company support team will liaise with the Strategic Coordination Centre (SCC). This will ensure that key groups within the local atrategic response organisation, such as the Strategic Coordination Group (SCG), Scientific & Technical Advice Cell (STAC), Recovery Working Group (RWG) and the Strategic Media Advice Cell (SMAC) are briefed on the ongoing situation and given key information to assist in decision making.

This structure is outlined further in Section 22.6 and in Figure 22.6-1.

Part 3: Recovery – Describes the process of recovery, returning an area affected by a radiation emergency to a state acceptable by local stakeholders. It gives an outline of the challenges faced and gives pointers to suggest solutions considering what can reasonably be done to prepare for recovery.

In addition, a supporting Concept of Operations provides a description of the UK response framework and associated capabilities that may be required in response to a radiation emergency. The UK ABWR response organisation will support this framework.

ONR Safety Assessment Principles (SAPs)

The ONR's Safety Assessment Principles (SAPs) [Ref-15] guide their regulatory judgements and recommendations when undertaking technical assessments of nuclear site licensees' safety submissions. For the UK ABWR the SAPs are used to guide assessments of the proposed new nuclear facilities and design as the SAPs represent ONR's view of good practice.

The SAP's contain fundamental principles which form the underlying basis for regulatory judgements made by inspectors. The principles reflect UK law and accepted international good practice and in recognition of their legal standing, use the 'must' form rather than 'should'. The guidance associated with each principle provides either further explanation of a principle, or their interpretation in actual applications and the measures against which judgements can be made.

For Emergency Preparedness Fundamental Principle FP.7 applies, this states that '*Arrangements must be made for emergency preparedness and response in case of nuclear or radiation incidents*'. This is supported by further guidance which will be met by the UK ABWR design as follows:

- Accident management strategies – These will be developed for the UK ABWR using a number of technical inputs including international guidance and experience of operating other similar power Plants, the UK ABWR Safety Case, the PSA, the REPPIR assessments and the latest Operational Experience. The development of AMGs is further detailed in Section 22.7.
- Use of shared or mobile equipment – This equipment and its required timescale will form part of a full time and motion and human factors study into response requirements to ensure it is available when needed and planned against a defined reference accident for the UK ABWR. Details and outcomes form the assessment will be contained within the site specific PCSR.
- Multi-facility sites – All assessments against emergency response carried out to support the site specific PCSR will ensure availability of response for a multi ABWR site.
- Long lasting events – The UK ABWR will contain emergency facilities that can be self-supporting for a period of seven days following a severe event.
- Emergency Procedures – The operating UK ABWR will have an approved Emergency Plan supported by an Emergency Handbook which will contain all the required emergency procedures for responders. These procedures will be written following full assessment of the potential worse case conditions to ensure actions can be carried out in a variety of situations. These documents will also work in parallel with Accident Management Guidelines described in Section 22.7.
- Emergency Exercises – All emergency response staff including control room staff will be required to undertake regular emergency training and exercising utilising the UK ABWR full-scope simulator, mobile equipment and equipment provided exclusively for emergency

response. A programme of validation exercises will also take place prior to operation of the UK ABWR to ensure accuracy and effectiveness of facilities, equipment and procedures.

- Accident Instrumentation - The design of the UK ABWR will include the use of severe accident instrumentation to ensure plant parameters can be understood even in extreme conditions.
- Facilities, equipment and supplies – All facilities, equipment and supplies required for emergency management will be tested, maintained and inspected dependant on their safety significance in accordance with the requirements of the UK ABWR Maintenance Schedule strategy. All equipment and supplies required to response to severe accidents will be adequately stored, protected or of sufficient robustness to survive the accident conditions. All essential equipment and supplies required for mitigation of severe accidents will be assessed further in the site specific PCSR.
- Off-site Logistical Support – Off-site equipment will be stored in a suitable location to support severe event response at a UK ABWR. Assessment of the size, amount, type and location will be assessed and further detailed in the site specific PCSR.
- Emergency Control Room – An on-site strategic Emergency Control Centre adequately robust to be able to continue a strategic response for seven days following a severe event without any external support will be provided at UK ABWR sites.
- Management of Team Deployment – The UK ABWR will provide robust and resilient facilities to manage the deployment of Emergency Teams and Emergency Services to the incident area. These facilities will be designed to function for seven days without any external support.
- Resource and deployment plans – As part of the accident management and emergency response plans an assessment will take place to ensure sufficient staff resource is available to address various accident scenarios and multi-unit events.

ONR Technical Inspection Guides (TIG)

The ONR TIGs [Ref-16] are written to provide guidance to site inspectors when undertaking compliance inspections against the site licence arrangements, this includes Licence Condition 11 (LC11) on Emergency Arrangements. The TIGs are not intended to be mandatory but help to provide a consistent approach to inspections for emergency arrangements and to assessment and evaluation of emergency exercises. Further details on how the UK ABWR arrangements will ensure compliance with LC 11 and therefore meet expectations in the TIGs will be covered in the site specific PCSR.

ONR Security Assessment Principles (SyAPs)

The ONR currently regulate security under the National Objectives, Requirements and Model Standards (NORMS) [Ref-17]. This provides guidance on how the industry can meet the duties placed on it by security legislation and supports the operator in meeting ONR security expectations and objectives.

In 2017, NORMS will be replaced by Security Assessment Principles (SyAPs) [Ref-18] providing more mature guidance. This will also bring security regulation into the goal setting, outcome based approach commonly used for other ONR areas of regulation. SyAPs will provide the guidance on

how operators can meet the objectives and duties placed upon them. The UK ABWR will be designed to meet the requirements under the new principles and will ensure close working and integration with Emergency Preparedness so that security and emergency response will be based on a cause diagnostic approach.

Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR)

The aim of the Radiation (Emergency Preparedness and Public Information) Regulations [Ref-6] is to establish a framework for protection of the public through emergency preparedness for radiation accidents with the potential to affect members of the public and to ensure the provision of information to the public prior to and during a radiation emergency.

REPPIR places legal duties on operators of premises where work with ionizing radiation is carried out, People who transport radioactive substances, all local authorities and employers of people who have a role in response to a radiation emergency. REPPIR will be applicable to the UK ABWR as an operating premises working with ionizing radiation but as required by REPPIR an assessment will need to be carried out to identify the quantities of radionuclides or fissile material associated with the UK ABWR and compare them with the threshold limits applicable to REPPIR. If these threshold limits are exceeded there may be the potential for a radiation emergency to occur and so REPPIR will apply. The current working assumption for the UK ABWR is that REPPIR will apply and there will be the potential for a radiation emergency to occur.

A key aspect of REPPIR is the need to develop On-site and Off-site Emergency Plans and that they contain the detailed arrangements for dealing with 'reasonably foreseeable radiation emergencies'. A reasonably foreseeable radiation emergency is one which is less than likely but realistically possible. The assessment of reasonable foreseeable events from a range of candidate accident sequences of different levels and different severities of radiological consequences have been analysised as part of the GDA and the details will be provided as part of the site specific PCSR phase. It should be noted that:

- A category of 'foreseeable events' has been defined in Chapter 5 (see Section 5.5) and this is not intended for direct application to REPPIR;
- The REPPIR guidance may change along with the REPPIR Regulations as part of the ongoing UK Department for Business, Energy & Industrial Strategy British Safety Directive Programme of work[Ref-19]. This may also result in revision of definitions including 'Reasonably Foreseeable'.

Control of Major Accident Hazards Regulations 2015 (COMAH)

The COMAH Regulations [Ref-13] are designed to prevent major accidents involving dangerous substances and limit the consequences to people and the environment. The COMAH regulations will be applicable to the UK ABWR design but the level of application will depend on strategy, levels and amounts of hazardous substances stored and used during operation of the plant.

COMAH gives two threshold levels, known as lower tier and upper tier both have qualifying levels and substances that, following assessment, will indicate to which level the UK ABWR will require application. It is a current assumption that the UK ABWR will apply to Upper tier requirements until assessments have been carried out and completed.

22.3.3 Key principles

To support development and design of robust and adequate emergency SSCs for the UK ABWR, the following guiding principles have been developed. The high level key strategic objective supporting all the principles is to ensure protection of the Public, Workers, Environment and Plant and to maintain security of the site at all times.

Emergency Principle 1

The priority for development and implementation of emergency arrangements will be Public, Workers, Environment and the Plant whilst ensuring security of the site.

The priority of the response in any event will be to protect the public from hazards arising from an event, protect workers on-site, protect the environment from any risks and hazards arising from an event and ensure that plant critical to safety is protected from the effects of an event.

Security of the site will also be a focus during an event ensuring prompt access is given to supporting agencies whilst still protecting nuclear material and Sensitive Nuclear Information (SNI).

Emergency Principle 2

All legislation will be complied with and appropriate guidance taken into account. This principle applies to all phases of the lifecycle but is especially important during the site preparation, clearance and construction phases due to the range and diversity of regulations that will be applicable. This principle requires compliance with all relevant health and safety, emergency preparedness, security and environmental legislation, some of which may be specialist and only apply to a particular activity or project phase. IAEA and UK government standards and guidance, along with good practice from the UK, from around the world and from other industries are to be met where required and actively considered.

Emergency Principle 3

Emergency Preparedness will be proportionate to the risks and hazards on-site.

The level of Emergency Preparedness will be informed by the understanding of the all risks and hazards posed by the work and site. A robust assessment of all the risks will be undertaken which does not focus solely on specific high consequence and low probability hazards to the detriment of others.

The nuclear hazards and risks will also be assessed within the nuclear safety case (noting that there may also be radiological hazards that arise from activities such as radiography); the environmental hazards and risks will be assessed and planned against through the Environmental Management Plan and other company arrangements, including the BAT case.

These assessments will provide an understanding of the potential urgency and scale of the response that might be required and hence, with human factors analysis of the tasks required, inform the structure and resources required. The site organisation will be such that it can (with the aid of loacal Emergency Services and responders) be expected to manage all required concurrent urgent actions and will be capable of scaling in appropriate time scales to manage more complex or more severe situations.

Emergency Principle 4

The design will support an integrated response at all times ensuring the "one response for all" philosophy. A consistent, integrated response to all events including nuclear, conventional, security and environmental events will continue throughout the lifecycle. This will avoid the need for separate response plans, structures and facilities, enabling the response structure to employ a proportionate and flexible response dependent on the event.

22.4 UK ABWR Design, Safety and Emergency System

The general discussion of engineered reactor safety systems and their roles in dealing with a range of postulated events including from design basis accidents, beyond design basis accidents and severe accidents is provided in a number of chapters in Generic PCSR. A general description of the design is also provided in Generic PCSR Chapter 9: General Description of the Unit (Facility), the fault studies are covered in Generic PCSR Chapters 24: Design Basis Analysis, in Generic PCSR Chapters 25: Probabilistic Safety Assessment and in Generic PCSR Chapter 26: Beyond Design Basis and Severe Accident Analysis. The information is thus not repeated here.

Following the Fukushima Daiichi accident, the relevant lessons learnt are incorperated into the UK ABWR design. Some aspects, referred to as countermeasures, currently included in the UK ABWR design are discussed in Generic PCSR Chapter 28 Section 28.5 “Response to the Fukushima Accident”. Many of the safety measures are housed in the Backup Building providing an additional layer of accident management capability. The additional safety measures include the following:

- Alternative water source-via tanks adjacent to the building;
- Backup Building Generator (BBG) for alternative AC power;
- Alternative reactor depressurisation: Reactor Depressurisation Control Facility (RDCF);
- Alternative water supply to the Reactor Building: Flooder System of Specific Safety Facility (FLSS);
- Related control, instrumentation and auxiliary cooling;
- Accident monitoring and control facilities.

22.4.1 Facilities

Backup Building

For the UK ABWR GDA design, the single unit has a dedicated Backup Building is a key mitigation/resilience measure for design basis faults, beyond design basis accident and severe accident scenarios. This building provides a number of accident management facilities and capabilities. The Backup Building will be located at such an elevation and/or position to minimise the likelihood of a co-incident loss of safety function with the Reactor Building from extreme external hazards.

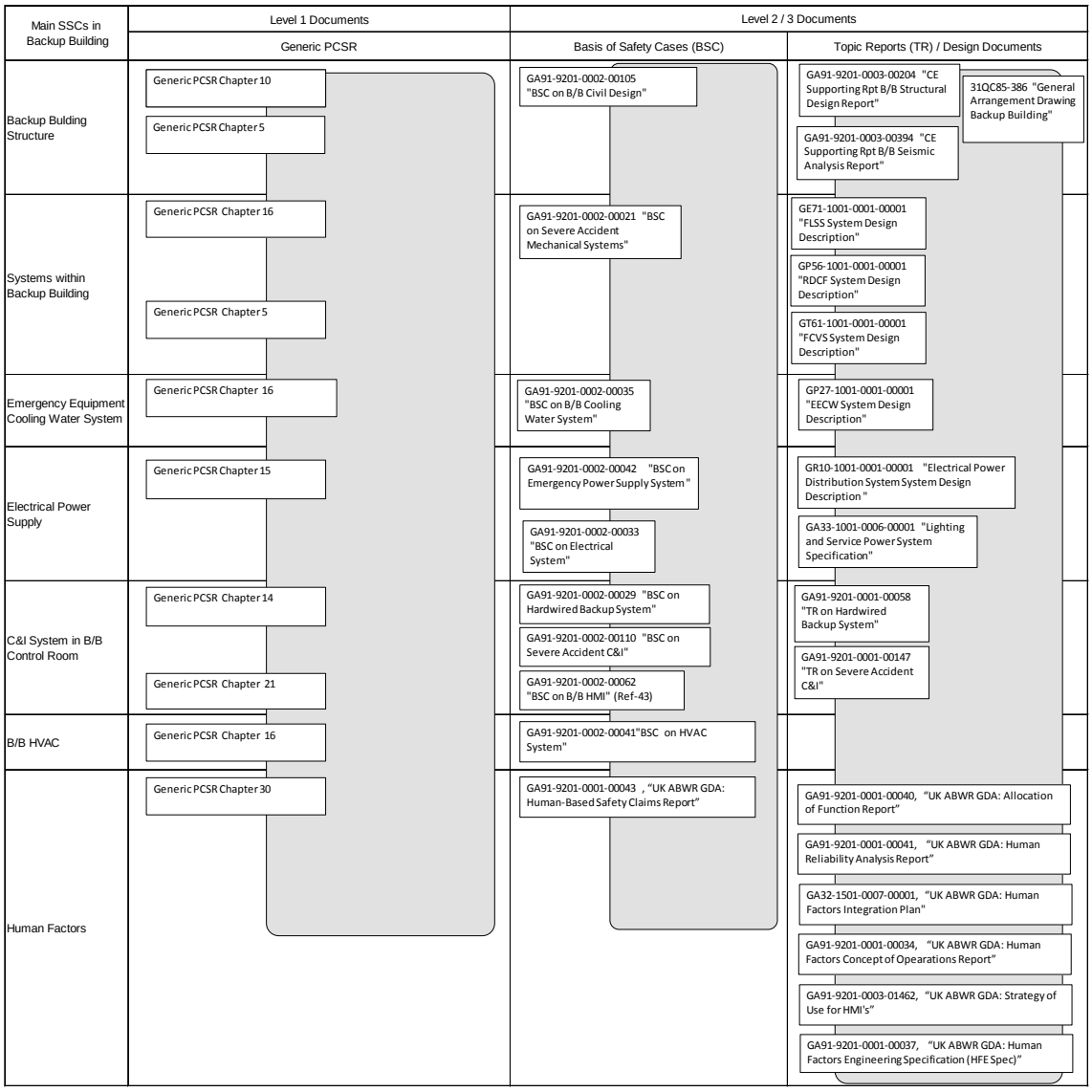
The Backup Building is a specific feature of the UK ABWR and its design is at a concept stage with further design details being developed during and after GDA. A Topic Report [Ref-20] has been developed as the central document for the B/B design, and will provide references to other documents giving greater details on specific design aspects. This will include descriptions of specific systems within the B/B, and provide an overview on how such systems will operate, and provide a description of the structure and the resilience of the B/B against extreme external events.

The Backup Building is designed to be robust following a severe event support to managing a severe accident. Table 22.4-1 provides a route map of where the description of the corresponding SSCs / facilities related to the Backup Building can be found.

Further details on the Backup Building and its functions can be found in Section 22.4 below and within the Topic Report [Ref-20]. The full Backup Building requirements are still under

development in GDA with the key focus on accident management capability and capacity, these other aspects will be developed further within the site specific PCSR.

Table 22.4-1 : Route map for GDA documents related to SSCs installed Backup Building [Ref-20]



22.4.2 Emergency Systems

Flooding System of Specific Safety Facility (FLSS)

The main role of FLSS is to supply cooling water by FLSS pumps installed in the Backup Building (B/B) in order to prevent core damage in the event of design basis fault, and prevent severe core damage, Reactor Pressure Vessel (RPV) breakage and Primary Containment Vessel (PCV) breakage in the event of beyond design basis faults.

The FLSS also provides cooling and makeup water for the Spent Fuel Storage Pool (SFP) to maintain the water level in the event where the water supply and cooling functions to the SFP fail.

The FLSS is designed to perform the following functions:

- provide cooling water to the reactor core.
- provide cooling water to the PCV spray header.
- provide cooling water to the Lower Drywell (D/W)
- provide cooling water to the reactor well.
- provide cooling water to the SFP.

The FLSS initiates automatically as a backup of the Emergency Core Cooling System (ECCS) for design basis faults and is designed to be operated manually from either the Main Control Room (MCR) or the B/B for beyond design basis faults. Further information on the FLSS can be found in the Design Description [Ref-21].

Flooding System of Reactor Building (FLSR)

The purpose of the FLSR is to supply cooling water to the Reactor Pressure Vessel (RPV), the Primary Containment Vessel (PCV), the Spent Fuel Storage Pool (SFP) and the Reactor Well and to maintain that cooling function following a failure of all other means of providing the cooling water function during Severe Accidents (SA). The FLSR uses cooling water from various water sources inside and outside of the plant site boundary by Mobile Water Injection Pump.

These Mobile Pumps will be supported by the necessary supporting equipment such as piping, valves and instrumentation. The Mobile Pumps will then make the connection between the required water sources and the purposely designed, installed and protected injection points. Further information on the FLSR can be found in the design description [Ref-22].

Reactor Depressurisation Control Facility (RDCF)

The purpose of the RDCF is to depressurise the Reactor Pressure Vessel (RPV) and thus enable reactor core cooling function at low pressure state as an alternative means in the event of faults where the principal reactor core cooling means formed by the Emergency Core Cooling System (ECCS) are not available.

The RDCF controls the Safety Relief Valves (SRVs) of the Nuclear Boiler System (NB) in order to depressurise the RPV and thus enable reactor core cooling function under fault conditions in which core cooling by the principal means is not available (ECCS or its support systems are not available). The RDCF controls the SRVs to provide depressurisation of the RPV so that cooling water can be supplied into the RPV by the Flooder System of Specific Safety Facility (FLSS) or the Flooder System of Reactor Building (FLSR) at low pressure state.

In addition, the RDCF is configured into two divisions to supply nitrogen gas to these four SRVs through the dedicated nitrogen gas cylinders.[Ref-23]

Alternative Heat Exchanger Facility (AHEF)

The purpose of AHEF is to recover cooling capacity of any one division of Residual Heat Removal System (RHR) and associated auxiliaries. This is done by connecting the mobile equipment to the Reactor Building Cooling Water System (RCW), to replace the functions of RCW or Reactor Building Service Water System (RSW) when they are lost. Further information on the AHEF can be found in the Design Description [Ref-24].

Alternative Nitrogen Injection System (ANI)

The ANI is provided as a severe accident management system in the event that PCV venting is operated. The purpose of the ANI is to keep the hydrogen concentration inside the Primary Containment Vessel (PCV) below the flammability limit. This is done by supplying nitrogen gas into the PCV which prevents a PCV break due to negative pressure caused by restarting of PCV cooling.
The ANI can also be utilised in the event that PCV venting is operated during Design Basis Accidents (DBA). During the post severe accident phase following PCV venting, the ANI can be used to supply nitrogen gas to the both sides of the Wet Well (W/W) and the Drywell (D/W) in order to inactivate the PCV atmosphere. Further information on the ANI can be found in the Design Description [Ref-25].

Alternative Power Supply

Alternative Power supply following a Loss Of Off-site Power (LOOP) or Station Black Out (SBO) will be provided by the following means:

- Emergency Diesel Generators (EDGs)
  The primary function of the EDGs is to supply power needed to shut down the reactor safely following a LOOP or SBO. The EDGs will also be used to supply power to the electrical systems to support the delivery of Safety Functions when a Loss Of Coolant Accident (LOCA) should occur simultaneously with a LOOP or SBO.
- Backup Building Generators (BBGs)
  The primary function of the BBGs is to supply power to diverse provisions which is necessary for reactor safety in the event of a LOOP and combined LOCA. Further information on alternative power supply can be found in the supporting Basis or Safety Case [Ref-26].

Remote Shutdown Facility

This system is designed to bring a reactor to cold shutdown state following a reactor scram condition. The remote operations are initiated from the Remote Shutdown Panels (RSPs) located externally from the Main Control Room (MCR).
All of the necessary equipment to bring the reactor from a hot shutdown state to cold shutdown are centralized for effective control and monitoring.
After a reactor scram, the Safety Relief Valves (SRV) and high pressure core injection system are actuated and the reactor is brought to a state of hot shutdown. Following this the suppression pool water is cooled by the suppression pool cooling mode of the Residual Heat Removal System (RHR).

The reactor pressure is then controlled using the SRVs and the reactor water level is maintained with water supplied by the high pressure core injection system, the reactor is also cooled by these functions. The reactor pressure is then reduced in a controlled manner with the reactor pressure depressurized to the pressure required for low pressure injection by the reactor shutdown cooling mode of the residual heat removal system. The reactor is then brought to a cold shutdown state with resulting low temperatures and pressures. Further information on Remote Shutdown can be found in the Remote Shutdown System System Design Description [Ref-27].

Severe Accident Monitoring

The instrumentation required for the measure and control of severe accidents is described in Generic PCSR Chapter 26 Section 26.4 “Severe Accident Analysis” and in the Accident Management Facility Basic Requirement Specification [Ref-28].

Safety Parameter Display System (SPDS)

The SPDS is one of the functions of the Plant Computer System (PCS). It provides a display of plant parameters from which the safety status of operation may be assessed in the MCR, TSC (ECC), TSC (AECC), etc. The primary function of the SPDS is to help operating personnel in the control room make quick assessments of plant safety status. Duplication of the SPDS displays in the EEC and AECC etc. will improve the exchange of information between these facilities and the control room and assist corporate and plant management in the decision-making process.

The SPDS operates during normal operation, continuously displaying information from which the plant safety status can be readily and reliably assessed. During emergencies, the SPDS serves as an aid in evaluating the current safety status of the plant, in executing symptom-based emergency operating procedures, and in monitoring the impact of engineered safeguards or mitigation activities.

22.5 Insights from OPEX and post Fukushima learning

As is discussed earlier the development of an emergency preparedness capability has noted the demands from international guidance, e.g. [Ref-1] and [Ref-2] and national requirements. Similarly, as reflected in Section 22.7, the accident management framework has been developed noting the principles and guidance from [Ref-4]. Following the Fukushima accident, there has been intense international examination to identify further lessons that could be learnt to further improve plant safety and emergency preparedness.

The UK ABWR design and the current consideration for emergency preparedness arrangements intended for the site specific PCSR phase has been evaluated against a number of studies [Ref-29], including notably:

- The recommendations of the ONR Chief Inspector [Ref-30]
- The review by the ONR of the UK responses to the ENSREG Stress Tests
- Observations and findings identified in a comprehensive report issued by the Director General of IAEA [Ref-31].

The scope of the evaluation in [Ref-29], outlined in Section 26.5, was also extended to include the considerations made for some UK nuclear power plants and designs for earlier GDA. More specifically, a number of key findings were identified in the IAEA Director General report against the headings of:

- The accident and its assessment
- Emergency preparedness and response
- Radiological consequences and
- Post accident recovery.

Tabulated evaluations for the UK ABWR design and the current conceptual arrangement for emergency arrangements against lessons and observations under these headings were provided in [Ref -29]. It should be noted a further major study was performed by the ASME Presidential Task Force in the US for consideration for new nuclear plant build [Ref-32] and the findings are generally consistent with the ones evaluated in [Ref-29].

The conclusions from the evaluations reported in [Ref-29] are provided in Section 26.5.

Boiling Water Reactor Owners Group (BWROG)

Learning from the BWROG is being and has been incorporated into the ABWR design, this mainly covers learning on Severe Accident Response and Equipment and the development of an Accident Management Strategy.

22.6 Emergency Organisation, Facilities and Response[1]

A number of Emergency Facilities are proposed for the UK ABWR which will be required to provide resilience, diversity and the ability for the site to respond to accidents and emergencies even during the most severe event environments. The emergency facilities will be located both on-site and off-site to provide the right level of diversity, support and robust response. These facilities will also be supplemented by alternative facilities or arrangements to ensure a flexible and resilient response if the main facilities become untenable or are unsuitable to manage the event scenario. Exact physical locations of the Emergency Facilities will not be defined until site specific PCSR phase.

The operators emergency response will also be supported by local response and regional and national emergency centres, this is shown in Figure 22.6-1 and indicates the key connections between the levels of response. The operator's emergency response will also be fully integrated into the local, regional and national emergency response structures to support a single framework of civil response as defined in the Civil Contingencies Act [Ref-7] and supported by the Joint Emergency Services Interoperability Programme.

The remote siting of nuclear power stations also creates some specific local issues in terms of geography and remoteness. The remote nature of the sites assists in lessening the impact of an event on any area of high population but increases the response times for support such as Emergency Services. To ensure this does not impact on any potential event at the site and impact on personnel and public safety an assumption has been made that the site Emergency Response and Facilities need to be able to stand alone for a longer period of time and to be able to function following a severe event.

General requirements for such facilities are summarised as follows:

- Emergency facilities must be capable of dealing with simultaneous events;
- Alternate or backup emergency facilities or arrangements must be provided for key facilities, this will allow control and management of an incident in the event that main or primary emergency facilities are unavailable;
- Emergency facilities must be provided with secure and resilient power supplies that allow continued functionality after a loss of off-site power or station black out for a period of seven days;
- Key Emergency facilities will need to be self-supporting for a period of seven days;
- Services to the emergency facilities (e.g. heating, lighting ventilation, water and sewerage) must be resistant to the same initiating events as the building itself;
- Provisions and services for the emergency facilities (e.g. food, water and sewerage) must be protected from contamination (radioactive, biological and chemical) so as to remain available whenever the facility is occupied.

[1] The SSCs and arrangements described in this Section are conceptual for the UK ABWR and will be developed further in the site specific PCSR, this includes size, layout and location of facilities, detailed roles and responsibilities and detailed architecture of systems and components.

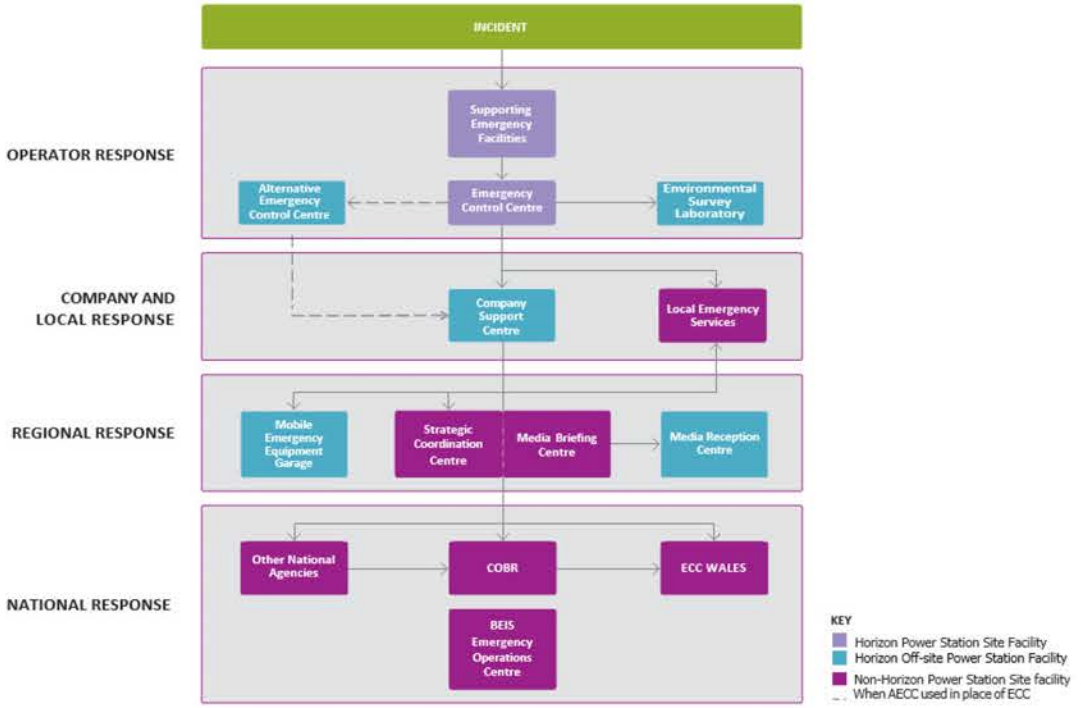


Figure 22.6-1: Conceptual Emergency Response Structure to be developed in the site specific PCSR

22.6.1 On-Site Response

On-site emergency response facilities are split into two categories, the first being dedicated facilities which are separate facilities dedicated and only used for emergency response purposes. The second being emergency facilities within other operational facilities but which are used during an emergency, these are both described below.

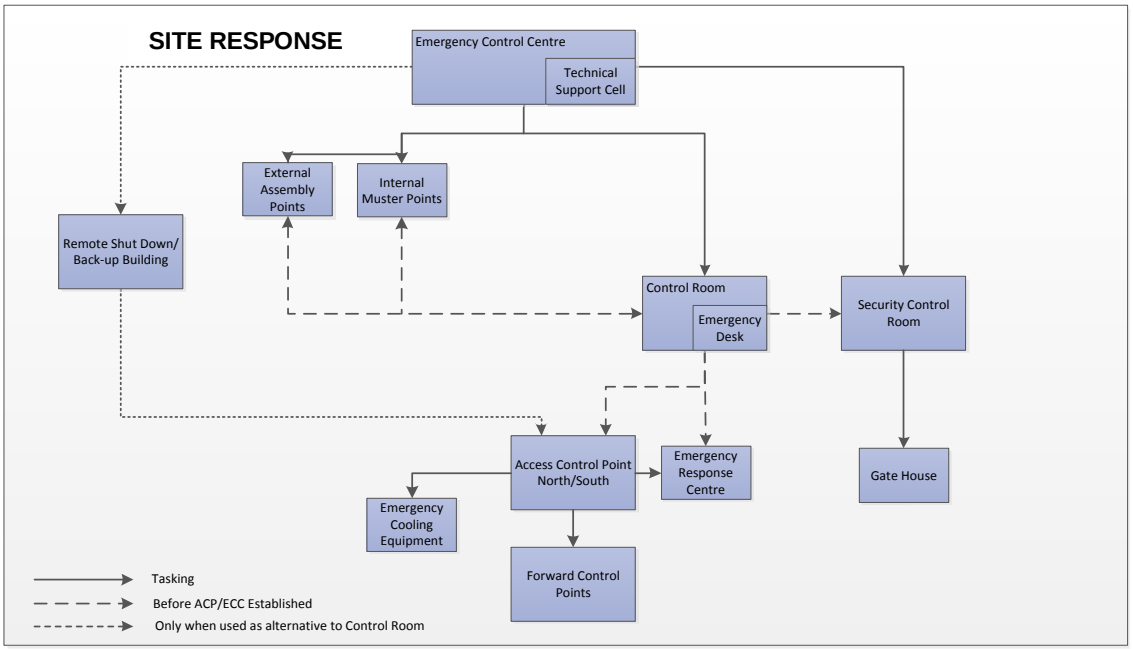


Figure 22.6-2: Conceptual On-site Emergency Response Structure

Dedicated Facilities

Emergency Control Centre (ECC)

The ECC is the Strategic command centre for the response; it is not used unless required but will be staffed by a team of trained responders led by the Emergency Controller who has strategic control of on-site response. The ECCs functions will include; formulation of public countermeasure advice; collection, co-ordination and dissemination of incident of information; collection, co-ordination and dissemination of environmental and radiological information; co-ordination of on-site assembly and mustering of staff; setting the site response aims, focuses and actions; provision of technical advice to the control room and other emergency centres and formulation of media statements and focused media response.

The ECC will also provide incident information to the Company Support Team who will be the conduit of information to all external agencies via the Strategic Co-ordination Centre (SCC) as well as providing information and advice to local agencies responsible for managing the off-site response.

To assist in giving the correct instruction and guidance the Emergency Controller will be supported by:

- Radiological expertise which has access within the ECC to Radiological Monitoring information to formulate off-site countermeasure advice, on-site radiological protection and give advice on authorising emergency dose levels;
- An Information & Administration Team which will assist in accounting for staff and management of the flow and recording of information;
- A Site Security Team to give advice and guidance on maintaining security of the site and response to a security event;
- Site Support Team to organise administration, facility and logistical support for the response and emergency facilities;
- A Technical Team to provide detailed technical information to support the Control Room, to support damage repair and to provide organisation of the emergency support systems;
- Media Team to provide media response and manage media elements such as social media and press response;
- Liaison Officers from the local Emergency Services.

The ECC will be physically connected to a Technical Support Centre which will house the Technical Support Team. The ECC will be protected from beyond design basis and severe accident events as far as reasonably practicable and also provide welfare and sleeping facilities to enable it to be staffed for seven days without external support. There will also be an Alternative Emergency Control Centre provided off-site to ensure resilience during severe events.

Technical Support Centre (TSC)

The TSC will be located adjacent to the ECC and will be populated by a Technical Support Team. The team will have access to plant data in the form of live reactor telemetry and readings, manuals, drawings and emergency support processes (EOPS, SMAGs). They will formulate advice and direction for the control room team to assist in controlling a reactor or plant event.

The TSC will have secure and reliable communications with the control room and outside sources of technical support. This will include a Corporate Technical Support Role within the Corporate Support Team to provide technical information directly to the SCC and Scientific & Technical Advice Cell (STAC). An alternative TSC will also be provided within the alternative emergency control centre.

Access Control Point (ACP)

The ACP is the site tactical centre that controls access to and from the site and the incident area during an emergency. It is led by an Access Controller who leads the tactical deployment of resource including response teams and equipment to support the aims and focuses of the ECC.

The ACP will be staffed by a team of trained responders who will carry out a number of varied roles and tasks including dressing and dispatching of teams (including BA control); monitoring and decontamination of returning teams, equipment and casualties; casualty assessment, treatment and care and briefing and debriefing of response teams and emergency services.

The ACP will be protected from beyond design basis and severe accidents events as far as reasonably practicable and will also include welfare and sleeping facilities to enable a number of personnel to staff the ACP for up to seven days without external support. An alternative ACP will also be provided on-site to provide an alternative location if the event situation affects the main ACP.

Emergency Response Centre (ERC)

The Emergency Response Centre will store the Emergency Response Vehicles (except those required for emergency cooling); required response equipment and specialist equipment such as hydraulic cutting equipment, chemical response equipment and foam generation equipment.

The ERC will be the initial dispatch point for the Initial Emergency Response Team, where they will receive a direct briefing from the Shift Manager; get dressed in the correct PPE; ready required equipment and vehicles and then dispatch directly to the incident.

The ERC will also contain a number of other response vehicles for emergency support teams such as a Radiological Response Team and Damage Repair Team. The dispatch of these vehicles and teams will be controlled by the Access Control Point.

Emergency Cooling Equipment Garage

This garage will house the required equipment for mobile emergency core cooling vehicles and equipment. The Section 22.4.2 on FLSR gives more information regarding the functions and requirements of this equipment. The garage will be, as far as reasonably practicable, protected from beyond design basis and severe accidents events.

Emergency Facilities within Other Operational Facilities

Emergency Desk in Control Room

The Control Room will have a dedicated emergency desk area for the management of the site emergency response. The Control Room will be the first to receive indication that an incident has begun from reactor telemetry, notification or a combination of both. The Shift Manager will be the Initial Site Emergency Controller and will use this desk to manage the initial site response to the incident before the ECC is established, this may include initial notifications and declaration; dispatch of the initial Emergency Response Team; communication to site personnel and initial warning and informing of the public.

This desk will house the required emergency system displays to support the initial decision making; communication systems and will also contain all the required initial response procedures.

Internal Muster/Shelter Stations

A number of internal Muster/Shelter Stations will be provided across the site within many of the buildings to protect personnel in the event of a radiological or chemical emergency. The Muster/Shelter Stations will be sized appropriately to house the numbers of personnel realistically expected within the areas and will contain water; KI Tablets; Monitoring equipment; miscellaneous support equipment and a method of communicating directly with the Control Room and ECC.

Emergency Support Systems

A number of key Emergency Response Systems will be integrated into the response to support the gathering and dissemination of information and to ensure robust communications during a response.

Incident Information Management System

An Incident Information Management System will be established for the UK ABWR, this system will be populated with incident information from the site and will be disseminated to all on-site and off-site emergency centres including the Strategic Coordination Centre and the BEIS Emergency Operations Centre.

Radiological Monitoring Systems (Nuclear Industry Airwave System (NIAS))

A Radiological Monitoring System will be available to give real time radiological data from across the plant, around the boundary of the site and in the local area. This may be one fully integrated system or it may be a number of different systems that provide radiological data to the site Control Room, ECC and AECC to support decisions and advice such as initial declaration; advice to the public on countermeasures; advice to the SCC; advice on deployment of teams for mitigation of the event and advice to the emergency services.

There will also be a radiological monitoring system for reporting of off-site survey data from monitoring teams. This is currently the Nuclear Industry Airwave System (NIAS) for the existing UK NPPs but may change in the future to embrace evolving and emerging technologies. This system will feed live monitoring data into the ECC and AECC to support decision making and formulation of advice.

Metrological System

A Metrological System will be provided within the Control Room, ECC and AECC which will give indication and information on wind direction, speed and weather stability. This will help to support decisions on countermeasures to protect the public in a radiation emergency.

Communication & Alarms

An integrated Public Address and Voice Alarm system will be installed across the site, this will provide all staff with initial alarms (and beacons) followed by automated voice messages to give instruction. This system will also enable communication with staff across the site with control points being situated in the Control Room and ECC to enable the Emergency Controller to give emergency messages and situational briefs.

A site wide radio system will be used by the Emergency Responders with a dedicated emergency channel, this radio system will as far as reasonably practicable integrate with the Emergency Services radio/Communication system.

22.6.2 Off-site

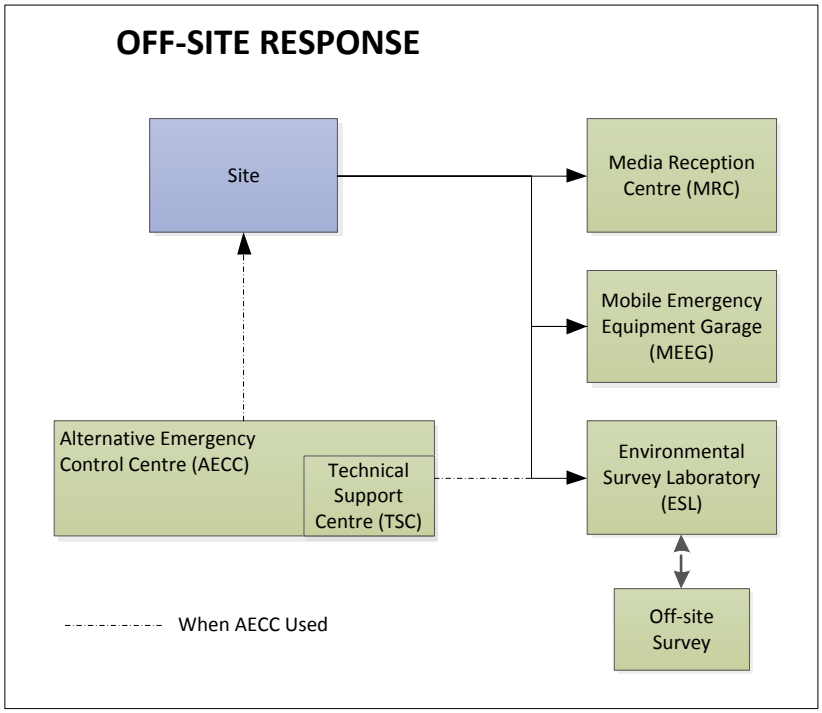


Figure 22.6-3: Conceptual Off-site Emergency Response Structure

Alternative Emergency Control Centre (AECC)

This provides an alternative emergency control centre for the Emergency Controller, Technical Support Team and support staff to withdraw to if the main Emergency Control Centre is untenable or if the situation dictates that this facility is better placed to deal with an event.

It will be able to fulfil the same key functions as the ECC; provide strategic control of the site and provide support to the site response but will have a reduced capability. It will contain an alternative TSC and will continue robust and reliable communications with the Control Room for advice and support. It will be, as far as reasonably practicable, protected from beyond design basis and severe accidents events.

Environmental Survey Laboratory

The Survey Laboratory will be able to provide analysis of radioactive and environmental samples during an emergency situation. It will house the analytical equipment necessary to process environmental and radiological samples.

Mobile Emergency Equipment Garage (MEEG)

This facility will be located a distance from the site and will be the location for numerous support

vehicles and equipment for beyond design basis and severe accidents scenarios. It will also be used as a marshalling point for arriving support onto the island before onward dispatch to the site.

22.6.3 Regional & National Emergency Response

Strategic Coordination Centre (SCC)

The SCC is the Regional Emergency Control Centre which is under the control of the Chief Constable of Local Police and will work in conjunction with the UK Strategic, Tactical and Operational control model. It will be populated by all the regional and national responding agencies and will formulate strategic focuses and actions including public advice. The SCC will co-ordinate and house a number of key meetings for the regional response which the operator will provide technical input into. The SCC will also provide the direct link to the Governmental response and provide COBR with information on the event.

Media Briefing Centre (MBC)

The MBC is the regional media briefing facility and is usually co-located with the SCC. This facility will co-ordinate all media enquiries and requirements including press conferences and interviews. The MRC near to site will support the MBC in delivering media messages and providing facilities for the media for press briefings.

Department for Business, Energy and Industrial Strategy (BEIS) Emergency Operations Centre (EOC)

The EOC would house the BEIS incident response team. The BEIS Incident Controller would be a senior official within BEIS. Other UK Government departments and the Devolved Administrations may be invited or may wish to send representatives to the EOC.

THE BEIS EOC will support COBR and will maintain regular contact with ONR's Redgrave Court Incident Suite; the local Strategic Coordination Centre; the devolved administrations emergency centres such as the Emergency Control Centre for Wales and other key agency emergency centres as required.

Cabinet Office Briefing Room (COBR)

The COBR is the Cabinet Office Briefing Rooms (COBR) facility and is the physical location, usually in Westminster, from which the central government response is activated, monitored and coordinated. COBR provides a focal point for the Government's response and an authoritative source of advice for local responders. COBR would almost certainly be activated in the event of a domestic or overseas nuclear emergency.

22.7 Accident Management

The UK ABWR will be designed such that environmental release of any radioactive material from the plant during all modes of operation is minimised to acceptable levels. The design also has a variety of engineered features, strategies and procedures for responding to design-basis and beyond design-basis accidents. To support this Severe Accident Management Strategy is designed to prevent or mitigate a severe accident following failure of the design basis accident measures. The current suite of procedures and guidelines dealing with accidents of different level of severity is comprised of the following:

- **Abnormal Operation Procedures (AOPs)**
  AOPs are used for postulated events that have been analysed and discussed in the design base analyses and are limited to a single initiating event following successful operation of the safety systems designed to respond to those events.
- **Emergency Operation Procedures (EOPs)**
  EOPs are symptom-based procedures that focus on operations required before core damage occurs and includes multiple failure induced severe accidents which are low frequency scenarios.
- **Severe Accident Management Guidelines (SAMGs)**
  SAMGs provide guidelines for preventing and mitigating accident scenarios in which severe core damage has occurred, reactor pressure vessel fails and containment integrity is challenged by the accident progression.

An overview of the above and a summary of the Severe Accident Management Strategy are provided in Generic PCSR Chapter 26 Section 26.4.3 “Severe Accident Management Strategy”. The Severe Accident Management Strategy will focus on preventing and/or mitigating severe accident progression, failure of nuclear reactor fuel and preventing containment failure to ensure no large amount of fission product is released to environment.

22.7.1 Integrated framework for Accident Management

Table 22.7- 1 below provides an overview of each of the procedure types, and the acronyms used.

Table 22.7-1: Overview of Operations Procedures

Procedure	Contents	UK	US	Japan
Unit Operating Procedures	Covers all main evolutions of the plant, from the Main Control Room.	UOP	GOP	UOP
System Operating Procedures	Integrated system procedures covering all tasks on systems, from MCR or plant.	SOP	SOP	SOP
Surveillance Test Procedures	Covers all surveillance requirements from Tech Specs.	STP	STP	STP
Alarm Response Procedures	First indications of off normal plant states. Used in MCR.	ARP	ARP	ARP
Abnormal Operating Procedures	Event based fault response procedures, with operations actions required to avoid scram requirement. MCR based.	AOP	AOP	AOP
Emergency Operating procedures	Symptom based fault response procedures, requiring scram and shutdown to cold conditions, with core intact and cool able geometry. MCR based.	EOP	EOP	EOP
Severe Accident Management Guidelines	Symptom based fault response guidelines, for faults resulting in core damage and non-cool able geometry. These guidelines are used by the Technical Support Centre, under control of the Emergency Control Centre, with assistance from the MCR & plant teams as required.	SAMG	SAG	AMG
Technical Support Guidance	Provides guidance instructions to Technical Support Staff.	TSG	TSG	TSG
SAMG/EOP – Support Procedures	Covers support actions under Emergency and Severe Accident conditions	ESP	ESP	SOP (just for AMG)

Figure 22.7-1 provides an overview of how the procedure types are intended to be used, and their interaction. The 3 blue bubbles at the top of this Figure indicate the source documents these being Emergency Procedure Guidelines (EPGs), Severe Accident Guidelines (SAGs) and Technical Support Guidelines (TSGs).

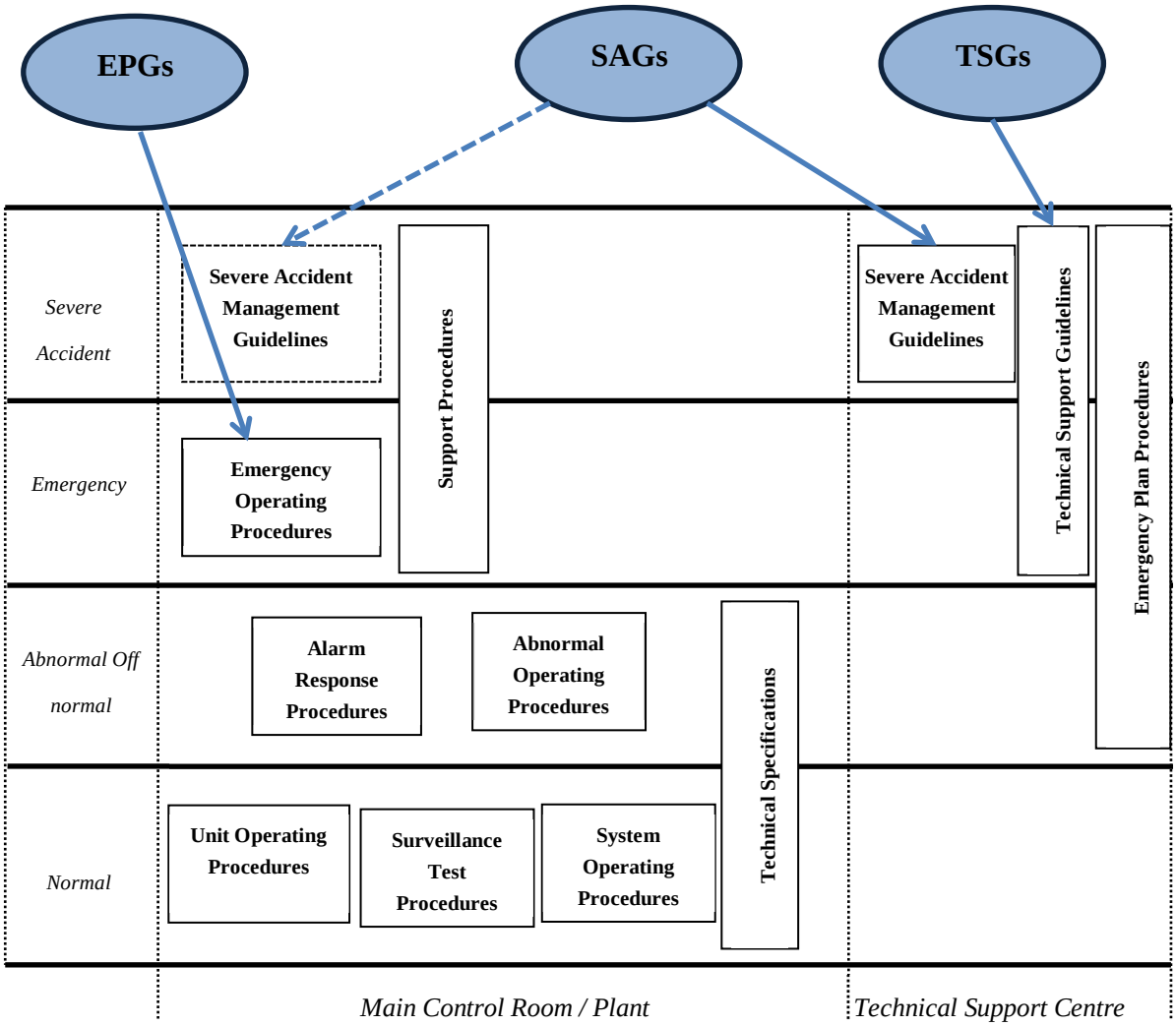


Figure 22.7-1: Operations Procedure Interactions

The EPGs/SAGs are divided into Emergency Procedure Guidelines (EPGs) and Severe Accident Guidelines (SAGs). The EPGs define strategies for responding to emergencies and events that may degrade into emergencies up until it is determined that the core cannot be adequately cooled. They comprise four guidelines and four associated contingencies:

Guidelines:

- RPV Control
- Primary Containment Control
- Secondary Containment Control
- Radioactivity Release Control

Contingencies:

- Alternate Level/Pressure Control
- Emergency RPV Depressurization
- RPV Flooding
- Level/Power Control

The SAGs define strategies applicable after it is determined that the core cannot be adequately cooled. They comprise two guidelines:

- RPV Control
- Containment and Radioactivity Release Control

The EPGs and SAGs function together as an integrated set of instructions. Each EPG guideline protects one of the principal barriers to radioactivity release through control of key plant parameters. The EPG contingencies form extensions to the top-level guidelines, providing more detailed instructions for controlling individual parameters under more degraded conditions. The SAGs extend the EPGs still further, addressing severe accident conditions. These guidelines and contingencies are adopted and adapted for site specific EOPs (from EPG) and SAMGs (from SAG) using established and approved processes.

22.7.2 Abnormal Operating Procedures (AOPs)

Abnormal Operating Procedures (AOPs) specify operator actions for restoring an operating variable to its normal controlled value when it departs from its normal range or to restore normal operating conditions following a transient. They are event based fault response procedures, with operator actions required to avoid scram requirement. AOPs are used for postulated events that have been analysed and discussed in the design base analyses and are limited to a single initiating event following successful operation of the safety systems designed to respond to those events. Provide detailed instruction to respond to specific plant abnormal conditions, i.e. loss of instrument air etc.

22.7.3 Emergency Operating Procedures (EOPs)

Emergency Operating Procedures (EOPs) specify direct actions necessary for the operators to mitigate the consequences of events when operator actions are needed to restore the plant to a safe and stable state. The aim of emergency operation is to restore the plant to safe and stable conditions, while ensuring the fundamental safety functions are achieved. They are symptom based type procedures.

22.7.4 Severe Accident Management Guidelines (SAMGs)

Severe Accident Management Guidelines (SAMGs) are symptom based fault response guidelines, for faults resulting in core damage and non-cool able geometry. The Technical Support Centre, under control of the Emergency Control Centre, uses these guidelines with assistance from the Main Control Room & plant teams as required. The implementing actions are carried out using Emergency Support Procedures (ESPs).

22.7.5 Summary

As discussed above, for the site specific PCSR, the Accident Management framework will be based on the suite of generic procedures and they will be adapted accordingly. This approach will reap the benefits of shared learning from the international community through years of BWR operations and understanding of response to a variety of plant faults. This adaptation for the UK ABWR is underway.

For GDA, Severe Accident Management strategy consistent with insights from fault analysis has also been developed and an overview is provided in Section 26.4.3. A summary of the designed severe accident mitigation systems to enable the implementation of the strategy is also provided in Section 26.4.3. Early development of event based and symptom based procedures forming the AOP/EOP/SAMG structure has been provided for the Generic PCSR and this is summarized in Figure 26.4.2. In the site specific development, currently underway, benchmarking against the GDA procedures is necessary to ensure GDA analysis insights are captured.

22.8 Consideration of Lifecycle Aspects

22.8.1 Emergency preparedness during Construction and Early Commissioning

For the UK ABWR design careful consideration will need to be given to the construction timing for all emergency facilities to allow adequate time for commissioning, training, exercising and demonstration to the regulator. Some of these facilities may also be constructed early in the construction phase for use in emergency response during construction.

22.8.2 Emergency preparedness from the receipt of nuclear fuel

For the reciept of nuclear fuel, operational emergency arrangements must have already been approved by the regulator. Once nuclear fuel enters the site, operational emergency arrangements become active and will then endure for the ABWRs operational lifecycle.

22.9 Conclusions

This chapter provides an overview of the emergency preparedness arrangements intended for an operating UK ABWR. It explains the approach to providing an an integrated response to abnormal events or emergencies, as currently envisaged for the UK ABWR design built on a generic site. It describes conceptual arrangements that are not developed further in GDA, but are considered to be an important piece of information in providing the UK Regulators with early visibility of the anticipated future developments for an actual licensed site.

This chapter demonstrates in principle how arrangements can be put in place on a specific UK ABWR site to support an adequate and proportionate response to any abnormal event or emergency, to reduce the risk to levels that are As Low as Reasonably Practicable (ALARP). It does not include details of the site specific requirements due to geographic location, local requirements or regional differences.

The information provided includes an overview of relevant international guidance and the applicable regulations. The strategy for emergency preparedness is described, including interactions between the licensee and local and national organisations. Consideration of the anticipated resources required by the licensee to deal with any accident or emergency is provided. The Structures, Systems and Components (SSCs) that are included within the UK ABWR design reference to facilitate effective response to accidents and emergencies are briefly described, with links provided to other Generic PCSR chapters that provide further details of these particular SSCs.

The Accident Management strategy, including Severe Accident Management strategy, consistent with insights from fault analysis, has also been provided. This includes early development of event based and symptom based procedures for abnormal events, emergencies and severe accidents. In the corresponding site specific development, currently underway, benchmarking against the generic procedures is necessary to ensure all significant GDA analysis insights are captured. The Accident Management framework will be based on the suite of generic procedures, and they will be adapted as necessary for site specific use.

Clearly, significant future development work will be required in the site specific safety case to further develop the detailed requirements of Emergency Preparedness as the design progresses. This work will be the responsibility of any future licensee and operator.

In conclusion the UK ABWR will have adequate and proportional emergency arrangments in place ready for recipt of nuclear fuel to be able to deal with reasonabley foreseeable events with the ability to extend to support response to severe and beyond design base scenarios.

All emergency SCCs will be designed to be resilient and redundant to the degree required to protect essential nuclear safety systems and also to support a safe and controlled reactor shutdown in the event of an incident affecting its safety.

22.10 References

[Ref-1] International Atomic Energy Agency, 'Preparedness and Response for a Nuclear or Radiological Emergency', GSR Part 7, 2015.

[Ref-2] IAEA Safety Standard," Fundamental Safety Principles", SF-1, 2006.

[Ref-3] International Atomic Energy Agency, 'Arrangements for Preparedness for a Nuclear or Radiological Emergency', GS-G-2.1, 2007.

[Ref-4] International Atomic Energy Agency, 'Severe Accident Management Programmes for Nuclear Power Plants', IAEA Safety Guide No. NS-G-2.15, Vienna, 2009

[Ref-5] IAEA Nuclear Security Series No.20 - Objective and Essential Elements of a State's Nuclear Security Regime - Nuclear Security Fundamentals.

[Ref-6] UK Health and Safety Executive, 'A guide to the Radiation (Emergency Preparedness and Public Information) Regulations', HSE Books 2001.

[Ref-7] Her Majesty's Stationery Office, 'Civil Contingencies Act', 2004.

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Appendix A: Document Map